

## Original Article

# Comparison of cephalometric readings between manual tracing and digital software tracing: A pilot study

### ABSTRACT

**Aim:** The aim of the study was to analyze and compare the cephalometric readings between manual tracings with digital software tracings using Steiner's analysis.

**Materials and Methods:** The conventional lateral cephalograms of twenty participants were obtained. Six hard tissue landmarks were identified, and Steiner's analysis was carried out. The radiographs were manually traced, and the readings were recorded. Following this, the radiographs were uploaded in the FACAD digital software for digital tracing.

**Results:** SNA, SNB, lower incisor to NB angle, and linear values show statistically significant differences. The remaining parameters do not show statistical difference.

**Conclusion:** The results show a statistical difference between manual and digital tracing. The variation lies in the difference in identification of the hard tissue landmarks.

**Key words:** Cephalometric; digital tracing; landmarks.

### Introduction

For a very long time, cephalometrics has been an indispensable tool in orthodontics for diagnosis, treatment planning, and evaluation of dental and skeletal growth, posttreatment evaluation, and research work.<sup>[1,2]</sup>

Cephalometric tracings can be achieved by manual and/or computerized methods. The manual method was previously the only available method used for achieving and procuring cephalometric tracings and angular and linear measurements required for their interpretation. The main drawback of this method was in the fact that it was more time-consuming, particularly for orthodontists and was subjected to a high degree of operator error.<sup>[3,4]</sup> Although the radiographic film is quite stable, it tends to deteriorate over time which leads to a loss in the quality of the radiographic image.

With the rapid growth of computer radiography, digital tracing has slowly replaced the manual tracing methods. The use of both digital radiography and transformation of

manual film to a digital format offers several advantages - it is convenient to use, allows multiple analyses to be carried out at a time, promises convenience when generating treatment predictions, needs less storage space, permits superimposition of images, provides the option to manipulate the size and contrast of the image, and furnishes the ability to document and improve access to images to overcome the problem of film deterioration, which has been a major cause of information depletion in craniofacial biology.<sup>[5]</sup>

The concept of the digital radiographic image refers to the image captured from X-rays incidence and shown on the computer. It can be achieved by two different ways: through

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<b>Website:</b> <a href="http://www.orthodrehab.org">www.orthodrehab.org</a>	<b>Quick Response Code</b> 
<b>DOI:</b> 10.4103/2349-5243.197460	

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**How to cite this article:** Kamath MK, Arun AV. Comparison of cephalometric readings between manual tracing and digital software tracing: A pilot study. *Int J Orthod Rehabil* 2016;7:135-8.

systems with or without the adoption of radiographic films. These methods can also be called indirect or direct method. In the direct method, the image is acquired directly through a charged coupled device eliminating the use of radiographic film and darkroom. In the indirect method, also called hybrid system, a conventional radiography is registered by a video camera or scanner and transformed into digital format in a computer through a software program. Digital radiography offers several advantages since it permits improved assessment of the image using graphic and image processing software, which can reverse color scale, enhance specific areas, provide texture manipulation, and others. According to manufacturers, it also provides approximately 80% radiation dose reduction compared to conventional radiographies.<sup>[6]</sup>

Previous studies have shown that computer-aided cephalometric analysis does not introduce more measurement error as long as the landmarks are identified manually.<sup>[7]</sup> Therefore, manually identifying landmarks on a screen displayed digital images for cephalometric analysis is still a better alternative.

However, there are still some orthodontists who prefer manual method than the use of computers. One of the reasons is the inevitability of the financial investments in the software and the belief that the conventional method is the adequate technique.<sup>[8]</sup>

For digital cephalometry to develop as a better clinical tool in orthodontics, the cephalometric analysis represented by often used linear and angular measurements must be as comparable and reliable as it is on a conventional radiographic film.<sup>[9]</sup>

Hence, the present study was carried out to find which method is superior in terms of accuracy and adequacy.

## Materials and Methods

Twenty pretreatment cephalometric radiographs [Figure 1] of patients were chosen based on the following criteria:

- Good quality radiographs with no obstruction in identification of anatomical landmarks
- No previous history of orthodontic treatment
- Patient biting in centric occlusion.

The cephalometric analysis was done by the following two methods:

1. Manual
2. Digital.

## Manual method

All the lateral cephalograms were traced using a sheet of acetate tracing paper. The tracings were done on a view box with the tracing paper securely positioned over the radiograph with a masking tape.

After the tracings were done on the lateral cephalogram, the following hard tissue landmarks were identified: S (sella turcica), N (nasion), A (subspinale), B (supramentale), Gn (gnathion), and Go (gonion).

Once the landmarks were traced, the lines and planes were obtained, and Steiner's analysis was carried out [Figure 2].

## Digital method

The digital image of each cephalogram was obtained by transferring the selected images archives of the cephalogram folder to the FACAD software (Swedish company Ilexis AB, Linköping, Sweden). The cephalometric landmarks were identified on the displayed image and digitalized on-screen. Following this, the values associated with the components of Steiner's analysis were obtained automatically [Figure 3].

## Data analysis

Estimation of statistical differences of the cephalometric values by the manual and digital methods was executed by applying paired *t*-test. A *P* = 0.05 was used as the minimal level of statistical significance. All the data analyses were done using Statistical Package for Social Sciences (SPSS version 20) for MS Windows.

## Results

Table 1 shows the statistical values obtained. From the table,

**Table 1: Steiners Analysis values obtained by manual and digital method using paired t-test**

Parameter	Mean	n	SD	SEM	P<0.05
SNA (M)	81.55	20	4.67	1.04	0.0383*
SNA (D)	84.75		4.39	0.98	
SNB (M)	77.55	20	4.49	1.00	0.0001**
SNB (D)	82.80		4.66	1.04	
UINA angle (M)	34.90	20	7.35	1.64	0.0693
UINA angle (D)	30.00		10.53	2.35	
UI to NA linear (M)	8.45	20	3.58	0.80	0.5575
UI to NA linear (D)	9.15		4.07	0.91	
LI to NB angle (M)	34.85	20	9.57	2.14	0.0002**
LI to NB angle (D)	27.15		10.27	2.30	
LINB linear (M)	3.35	20	2.35	0.52	0.0002**
LINB linear (D)	7.75		3.23	0.72	
MA plane angle (M)	28.95	20	7.19	1.61	0.1397
MA plane angle (D)	27.20		4.85	1.08	

\**P*<0.05: Significant, \*\**P*<0.01: Very significant. M: Manual method, D: Digital method, SD: Standard deviation, SEM: Standard error of mean, UI to NA: Upper incisor to N-A, LI to NB: Lower incisor to N-B, MA: Mandibular



Figure 1: Preoperative lateral cephalogram

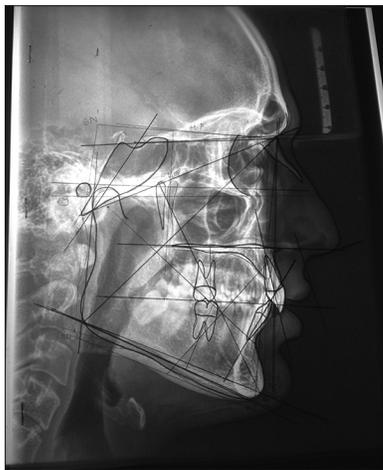


Figure 2: Manual tracing

we can observe that SNA, SNB, LINB angle, and linear values show statistically significant differences. The remaining parameters do not show statistical differences.

### Discussion

The aim of this study was to compare the accuracy of cephalometric readings of manual tracing of cephalograms to digital software tracing. As the conversion of an analog image to digital format involves many steps such as the hardware, software, computer functions, and settings, the likelihood of image distortion is increased.

The manual method is not only time-consuming but also allows more measurement errors caused by doctors. The reproducibility of cephalometric points in conventional method on paper in comparison to the analysis of digital image was controversial for a long time. The complicated process to obtain a digital record of X-ray, loss of data during digitization resulting in reduced quality of the image, or complicated and not sufficiently tested software analysis disputable in the past.<sup>[10]</sup> Nowadays, due to the technology advancement and necessity of data mobility, the manual method is becoming a handicap. Nowadays, digitizing X-rays has become the preferred method to perform cephalometric measurements. As technology evolves, it becomes increasingly easier for professionals to adapt to the many routine tasks of clinical practice.<sup>[11]</sup>

Linear measurements may be altered by the inclination of the reference line, and angular measurements cannot indicate

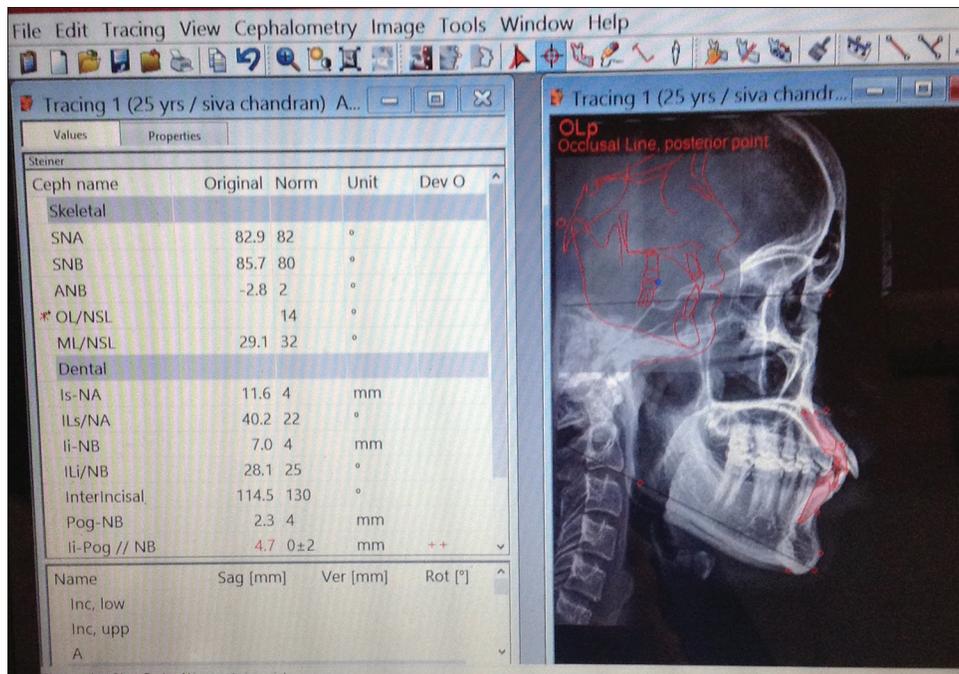


Figure 3: Digital software tracing - FACAD

correctly the jaw relationship in the case of extreme facial divergence.<sup>[12]</sup>

The cephalometric radiographs used in this study were randomly chosen and portrayed the quality of daily routine work. The variables used in this study were commonly used cephalometric variables for orthodontic diagnosis, treatment planning, and evaluation of treatment results.<sup>[8]</sup>

Steiner's analysis is commonly used for orthodontic investigation, treatment planning, and evaluation of orthodontic treatment.

Landmark identification is greatly affected by operator experience, which is just as crucial as the tracing method itself. Because interoperator error has in general been found to be greater than intraoperator error as stated by Sayinsu *et al.* to reduce the error, all measurements in this study were carried out by the same examiner.<sup>[13]</sup>

In this study, the analysis of the results obtained when correlating the cephalometric measurements recorded in digital and manual tracings revealed values that showed statistically significant differences. These findings reinforce those of Chen *et al.*<sup>[3]</sup> and Bruntz *et al.*<sup>[14]</sup>

The differences in the values were most probably due to the difficulty in identification of landmarks in the digital version of the radiograph due to change in image quality and morphing of the radiographs as well as differences in measurements of the values for the analysis due to inaccurate landmark identification. The ease of identification of anatomical landmarks in the analog radiographs as well as the reliability of manual recordings of the analysis values makes manual tracings a more accurate and dependable method for cephalometric analysis.

## Conclusion

Based on this study and the results obtained by comparing measurements obtained on performing Steiner's analysis using manual and digital tracings (FACAD software), it is justified to conclude that the manual and digital tracings show statistical significant difference.

## Financial support and sponsorship

Nil.

## Conflicts of interest

There are no conflicts of interest.

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